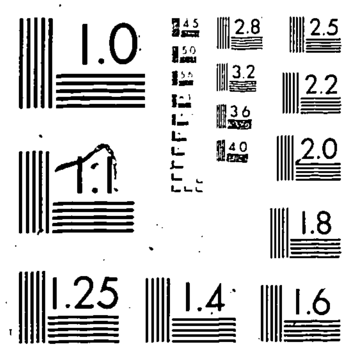


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ABSTRACT

Twelve research reports related to mathematics education are abstracted and analyzed. Four of the reports deal with various teaching methods, four with student aptitudes, four with student learning and understanding, and one with classroom practices. Research related to mathematics education which was reported in RIE and CIJE between October and December 1978 is listed. (MP)

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# INVESTIGATIONS IN MATHEMATICS EDUCATION



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A note from the editor . . .

With this issue, a return to the use of "Abstractor's Comments" has been made, in place of "Critical Commentary". The first meaning of "critical", as given in two Webster's dictionaries, is "tending to find fault" and "inclined to criticize severely and unfavorably". "Exercising or involving careful judgment or judicious evaluation", the sense in which the word is used in IME, comes later in the definition. Many persons tend to apply "critical" only in the negative sense. It is hoped that the use of "Abstractor's Comments" might encourage a broadened scope of critique. I have become very concerned about the current broadened stream of negativism and disenchantment about research. We need to note weaknesses and raise concerns: that is one reason why IME was established. But we also need to note positive aspects of research and to applaud promising directions. There are fallacies of research design and fallacies in applying research designs -- but every so often we do find out something, or confirm something, through research. Researchers need encouragement to continue, as well as to improve.

Fortuitously, "Abstractor's Comments" is a more appropriate heading for the reactions of several abstractors in this particular edition of IME. In one case, the abstractor chose to comment on the broader issue raised by the research report; in another instance, the abstractor presents some considerations for further research. Such comments seem (to the editor) to be appropriate for this journal, as well as the "judicious evaluation" of research.

One item in this issue of IME was prepared by the author of a set of articles previously abstracted. He adds a comment to extend the interpretation of those abstracts. Such statements by authors of abstracted reports are welcome. A reviewer interprets a report in terms of his or her perception of the words in the report; the author can extend the interpretation when it is apparent that misinterpretation occurred. Similarly, while a reviewer is entitled to his or her own opinion about a research report, an author is entitled to reply. Such professional responses will be published (if any are received).

Errors can also be made by editors. In this issue (and possibly in the next one), several reports have been abstracted for a second time. One stage of checking was omitted and, as a result, second abstracts were inadvertently requested. To have more than one abstractor's comments on a research report is a welcome bonus. But I apologize to the abstractors who also had to spend time developing a second abstract. I shall try to avoid this inadvertent error in the future.

Marilyn N. Suydam

Winter 1979

Barnett, Jeffrey C. and Eastman, Phillip M. THE USE OF MANIPULATIVE MATERIALS AND STUDENT PERFORMANCE IN THE ENACTIVE AND ICONIC MODES. Journal for Research in Mathematics Education 9: 94-102; March 1978.

Abstract and comments prepared for I.M.E. by ROBERT KALIN, Florida State University.

1. Purpose

The experimenters' goal was to determine whether actual physical experience with certain manipulative devices was necessary in order for preservice elementary teachers to be able to demonstrate numerical and structural properties at the enactive and iconic abstraction levels.

As conceived by Bruner (1964), the meanings of enactive and iconic are, respectively,

a. a set of actions appropriate for achieving a certain result; and
b. a set of summary images that stand for a concept.

The experimenters carried out their general purpose through three specific hypotheses:

In measures of

a. ability to demonstrate numerical and structural properties of the four basic arithmetic operations in the enactive mode,
b. ability to demonstrate numerical and structural properties of the four basic arithmetic operations in the iconic mode, and
c. mathematical achievement,

there are no significant differences between subjects who are required to operate in both the enactive and iconic modes and subjects who are restricted to operating only in the iconic mode.

2. Rationale

Many educators have been claiming that considerable use of manipulatives is beneficial in elementary school mathematics instruction. This assertion has carried over to a claim that in-service and preservice elementary school teachers need to be educated in their use.

The experimenters noted that some research had concluded that use of manipulative devices by preservice teachers in college methods courses had a beneficial effect upon their achievement in or their attitude toward mathematics, but that other research had shown conflicting results. In view of the expense in time and money necessary to give these college students an appropriate experience with manipulatives, the experimenters felt their study was needed.

3. Research Design and Procedures

One of two sections of elementary education majors in a mathematics methods course was by random means assigned to the Experimental treatment, the other to the Control treatment.

The instruction in both cases consisted of a one-hour lecture twice a week, together with a two-hour laboratory period each week for three weeks. The subject matter was whole number properties (properties of (a) addition and subtraction and (b) multiplication and division). Although the Experimental and Control sections met separately, attempts were made to keep the instruction equivalent in all respects but one:

a. The 39 Experimental students did each laboratory exercise on their own using the appropriate manipulatives in the enactive mode before completing the exercise in the laboratory manual (Jungst, 1975) in the iconic mode.

b. The 39 Control students did the laboratory exercises in the iconic mode only.

In view of the use of intact groups rather than random sampling from the population, the experimenters decided to use analysis of covariance, the covariate being a 40-item, multiple-choice mathematics test similar to the final examination in the prerequisite mathematics content course.

To test the second hypothesis--ability to demonstrate in the iconic mode--a criterion (Test 1) of 20 problems like those in manual, requiring students to respond in the iconic mode, was administered during the last lecture period of the third week. To test the third hypothesis--mathematics achievement--a criterion (Test 2) of 20 multiple-choice mathematical items dealing with the four whole-number operations and their properties was administered during the same last lecture period.

To test the first hypothesis--ability to demonstrate in the enactive mode--a criterion (Test 3) of four problems covering the associative and distributive properties was administered to 38 students, 19 randomly selected from each group. This was an interview test, conducted by one of the experimenters, and requiring each student to demonstrate physically an answer to each problem by using centimeter rods, pegboards, or set demonstration objects.

## 4. Findings

The analysis of covariance led to these results:

a. (Laboratory) Test 1, testing ability to demonstrate in the iconic mode: did not reject the null hypothesis

b. (Interview) Test 3, testing ability to demonstrate in the enactive mode: did not reject the null hypothesis

c. (Mathematics Concepts) Test 2, testing mathematics achievement: reject the null hypothesis with an F value of 5.94 (significant at a $p < .025$ level)

## 5. Interpretations

The experimenters came to these conclusions:

a. Failure to reject the null hypotheses dealing with ability to demonstrate in the enactive and iconic modes suggested that teacher educators of mathematics need not have their students work with manipulative aids in order for them to learn to demonstrate the topics of this study.

b. The ability of the Control group to complete laboratory exercises in about 25 percent less time suggests that learning in the iconic mode could produce in less time the same ability to use manipulative devices.

c. Rejection of the null hypotheses in dealing with mathematics achievement seems to agree with other stu[illegible] suggesting that preservice elementary teachers, not having reached the

Piagetian level of formal operations, should learn mathematical concepts with the aid of manipulative devices.

## Abstractor's Comments

The indication that appropriate use of manipulatives can increase the mathematical competence of elementary education majors is encouraging, an improvement over the findings of some prior studies and in line with others. The profession needs to pursue this apparent opportunity, as an increased level of mathematical competence on the part of elementary school teachers would seem to be a worthy goal.

At first glance, the results on the other two hypotheses seem surprising, even disappointing, to (probably most) mathematics educators who would speculate that ability to demonstrate at the enactive mode is crucial. The surprise arises from these facts:

1. The Experimental group in a very real sense did everything the Control group did, <u>plus</u> instruction in the enactive mode as well;
2. The Interview Test called for the Experimental group to perform the way they learned, whereas it called for a new experience on the part of the Control group.

The results further seem contrary to the common experience of a number of mathematics educators in their work with in-service as well as preservice teachers, and to the current popularity of manipulative workshops in conventions. Two questions seem pertinent, considered in detail:

1. <u>Were the research design and statistical procedures appropriate</u>?

These technical aspects of the investigation seem to have been carefully and correctly carried out, within the limitations of having to do so in one university and with intact (previously enrolled) sections. Of course, it would have been better to have randomly assigned subjects to the two treatments from the total population of students due to take the course during the academic year, and to have done so for at least two years. Intact groups in a single term are prone to too many unpredictable influences beyond the mathematical competence covariate sampled by the pretest. Even more important, if one is to generalize to the population of elementary education majors in the U.S.A., then sampling from that population is desirable in some more general way than pre-selecting one university.

Such features were understandably beyond the immediate capabilities of the experimenters. Indeed, at this point in the state of knowledge about such matters, the scope of this experiment was sufficient. To help increase this knowledge, perhaps these experimenters and certainly others in other circumstances need to try equally-sized, revised versions of this investigation. In the interim, no one can generalize these results to the larger population with any degree of confidence.

2. Were the criterion tests and the instruction appropriate to the crucial goal--teaching better?

If this reviewer has correctly identified the laboratory manual units studied, then the exercises the students worked on are somewhat removed from what the manipulatives would be used for in an elementary school setting.

For example, students were asked to maneuver and/or picture various manipulatives to exhibit the associative and commutative properties of addition in such exercises as:

$$(3 + 4) + 2 = 3 + (4 + 2) \text{ and } 3 + 4 = 4 + 3$$

With numbers like these, such exercises can appear confusing yet trivial, and their purpose can be a mystery. But placed in the context of establishing a rationale for the addition algorism with numbers such as 34 and 5 or 25, maneuvers with manipulatives related to the properties can make more sense. Perhaps the exercises should have been like these:*

$$(30 + 4) + (20 + 5) = (30 + 20) + (4 + 5)$$
$$\text{or } (30 + 4) + 5 = 30 + (4 + 5)$$

It is still possible that the background of the students, together with the supporting lectures and the nature of the manual, would again result in the iconic mode being sufficient for success in (Laboratory)

*The laboratory manual does contain units in which such problems are studied, but these occur later and were quite clearly not a part of the instructional treatment.

Test 1 and (Interview) Test 3. The question would then shift to the much more difficult criteria to measure: is the enactive mode necessary for students to be able to teach properly?

A related issue was raised in passing by the experimenters: some Control students expressed a negative attitude towards having to operate only in the iconic mode. Such a reaction has been noted in other studies in somewhat similar circumstances (Armstrong, 1973). It seems natural to expect that elementary education majors, typically being at less than the formal operation level of Piaget (Adi, 1976), would react negatively to drawing pictures to represent mathematical properties in apparently useless circumstances. Stated more positively, an improved attitude on the part of those operating in the enactive mode would seem predictable. Such an issue is worthy of investigation, as a more positive mathematical attitude for this group would be desirable.

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Jungst, D. G. Elementary Mathematics Methods: Laboratory Manual. Boston: Allyn and Bacon, 1975.

Barr, David C. A COMPARISON OF THREE METHODS OF INTRODUCING TWO-DIGIT NUMERATION. Journal for Research in Mathematics Education 9: 33-43; January 1978.

Abstract and comments prepared for I.M.E. by EDWARD C. RATHMELL, University of Northern Iowa.

1. Purpose

Young children are expected to use three types of representations for numbers beyond ten. Included are concrete materials that show tens and ones, two-digit numerals, and the usual oral number names. This study was designed to compare the effectiveness of three instructional sequences for helping children relate these three types of representations and apply these skills to other numeration tasks.

2. Rationale

There is a difference of opinion among mathematics educators about how counting should be related to introductory two-digit numeration experiences. Some feel that initially students should not count beyond ten. Groups of tens and ones can be formed and used to develop meaning for two-digit numerals before counting beyond ten and using the usual number names. Others feel that counting beyond ten is the starting point for introducing two-digit numerals. Evidence from one previous study suggests that the latter approach is beneficial; however, there were limitations to that study. This study was designed to compare the effectiveness of using three different types of counting in the development of two-digit numeration.

3. Research Design and Procedures

The sample consisted of 213 students in eleven kindergarten classes from three school districts in central Illinois. Kindergarten children were chosen because they had not previously been introduced to two-digit numeration.

Prior to assigning students to a particular treatment, four pretests were given. They included:

(1) Counting Test. This was an individually administered check to determine if each child could count rationally to ten. These children were labeled counters. Thirteen students failed the test and were excluded from the study.

(2) Material → Symbol Test. The class was shown six sets of tens and ones and the students were asked to write the appropriate numeral for each set. Seven students who already possessed this skill were excluded from the study.

(3) Verbal → Symbol Test. The experimenter orally named six numbers (two-digit) and asked the children in the class to write the symbol for each. A student with four or more correct responses was classified as a numeral writer.

(4) Conservation of Cardinal Number Test. This was a class-administered test consisting of eight items. The experimenter manipulated sets on the flannelboard and asked, "Are there the same number of (dogs) as (children)?" The students had to circle a YES or NO after each question. Children who scored less than four were classified as nonconservers. Partial conservers scored from four to six and conservers scored more than six.

Based on the results of these pretests, the students were assigned to one of the following: (1) nonconservers, (2) partial conservers and counters, (3) partial conservers, counters, and numeral writers, (4) conservers and counters, or (5) conservers, counters, and numeral writers. The members of each of these were then randomly assigned to one of three treatments.

The experimenter, an assistant, and the classroom teacher taught the three experimental treatments in the same classroom at the same time. The teachers were rotated among the treatments to control for teacher-effect.

Each of the three treatments received (1) the pretests, (2) ten 20-minute lessons given on alternate school days, (3) the posttests, (4) three maintenance lessons one week apart, and (5) retention tests given four weeks after the posttests.

In Treatment A, the emphasis was on counting by ones. The students counted sets of objects and practiced reading and writing numerals associated with the sets. Two of the lessons late in the sequence related two-digit numerals to tens and ones.

In Treatment B, students did not count beyond ten. The emphasis was on grouping sets by tens and ones and developing meaning for two-digit numerals from these groupings. The oral number names were associated with the numerals late in the sequence.

In Treatment C, the emphasis was on counting by tens. This instructional sequence was very similar to Treatment A except the students counted by tens rather than by ones. (Example: 10, 20, 30, 40, 41, 42 rather than 1, 2, 3, ... 39, 40, 41, 42)

There were two dependent measures. The Skills Achievement Test consisted of 24 translation tasks. A number was represented by one of the three types of representation (concrete, oral, or numeral) and the children were asked to translate to one of the other types. There were four items for each of the six translations. The Applications Test consisted of 16 items. There were four each involving the number line, comparing numbers, writing a numeral for a given number of ones and tens, and adding or subtracting a one or a ten from a given number. The retention tests were similar; however, there were only half as many items on each test.

Multivariate analysis of variance was used on the Verbal → Symbol and the Conservation Pretests and for each dependent measure at both the posttest and retention test stage. The experimental unit was the mean treatment group score within a class.

4. <u>Findings</u>

a. No significant differences were found among the treatments on the pretests.
b. No significant differences were found among the treatments on the posttests.
c. There was a significant difference ($p < .05$) among the treatments on the retention tests. Discriminant analysis indicated the Treatment C was superior to Treatment A,

which in turn was superior to Treatment B. However, the difference between any two treatments is not necessarily significant.

5. Interpretation

The relative weakness of Treatment B is interesting because of the recommendations for it and the intuitive appeal of developing understanding prior to symbolization. This result is consistent with the findings of Rathmell (1972).

Most of the students in Treatment B were observed using ordinary counting behavior to obtain answers on the tests. They had not practiced this skill during the experimental treatment. Apparently, Treatment B did not alter the mental structures the children already had. The new knowledge was absorbed in the existing structure, but the preexisting counting behavior continued.

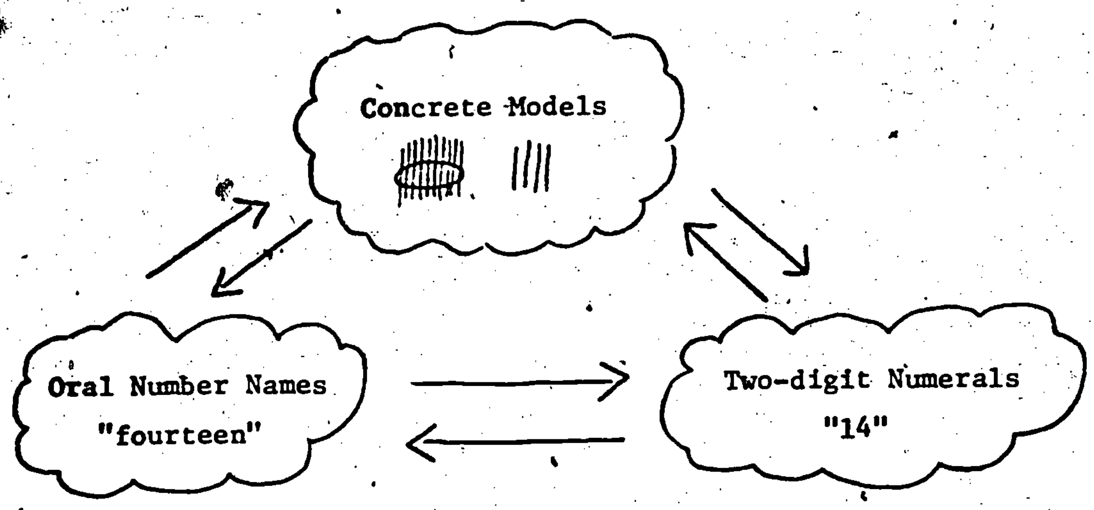
It is not surprising that Treatment C had a higher mean score than Treatment A. Treatment C was essentially a more efficient approach to Treatment A.

## Abstractor's Comments

The experimenter should be commended for conducting a good study on an important topic. This study suggests that counting by tens is a viable approach to helping children learn two-digit numeration; however, it does not provide specific information about how this counting helps. The following discussion about the thinking that children use is intended for future research consideration.

The effect of counting in the development of two-digit numeration has been investigated. Since "the difference between the three treatments is almost entirely attributable to the Skills Achievement Test," it is appropriate to analyze how the counting skills that were taught might help students perform these tasks.

The six types of translation tasks on the Skills Achievement Test are illustrated by the arrows in the following diagram. An example illustrating three different representations of fourteen is also included.




Consider how learning to count by ones beyond ten might help a child perform these translations. Given a concrete model, the child could count the objects one by one and determine the oral number name. Conversely, given an oral number name, the child could count objects and represent the number with a concrete model. Admittedly, the process of counting large sets by ones is not very efficient, but children who possess this skill would be capable of performing these translations. Counting by ones seems to offer little aid in making the other translations.

Counting by tens should help children make the same translations. This counting process is simply more efficient. Like counting by ones, it will be little help in making translations to and from numerals.

Now consider the effect of never having children count beyond ten. This counting and the resulting groups of tens and ones will not determine the usual oral number names. For example, if a child is given thirty-four objects and asked how many there are, the grouping will help the child determine there are 3 tens 4 ones. But, unless the student knows that 3 tens is thirty, the student will not be able to determine the number name thirty-four. The same knowledge is necessary in order to translate from the oral number name to a concrete representation if counting beyond ten is not permitted. Translations between concrete models and two-digit numerals are the most likely to be aided by this grouping. But even this requires that a child also know the relationship between sets of tens and ones and the recording scheme for two-digit numerals. This counting and grouping will be little value in reading and writing numerals.

It seems reasonable, based on the evidence from this study and the previous argument, that counting by tens shows promise of helping children with translations between oral number names and concrete models. It also has the added feature of involving groups of tens and ones which in turn can be related to two-digit numerals. It should be noted that counting by tens can also be a means to helping children learn that 3 tens is thirty, 5 tens is fifty, 2 tens is twenty, etc. This knowledge makes the translations between concrete models and oral number names even easier.

An examination of the lesson plans for the three instructional sequences in this study (as described in the dissertation which is the basis for this article) indicates the thinking that children are expected to use when reading and writing two-digit numerals. It is stressed that teens begin with 1, twenties begin with 2, thirties begin with 3, etc. This amounts to using a left-right scheme for reading numerals and often leads to a sound-sequence scheme for writing numerals. If a child is asked to write the numeral for seventy-three, the sound-sequence is seven-three. The numeral is then written left to right using the numerals in the order they were heard. However, this process can lead to reversals for the teens where the number of ones, rather than the number of tens, is said first.

The highest mean score on the posttest for this study was 42 percent. The abstractor, using instructional sequences similar to the ones in this study, found that first-grade children made relatively slow progress in learning to read and write numerals (Rathmell, 1972). Clearly the instructional sequences used in these studies are not as effective as might be expected from meaningful instruction.

It seems plausible that children would be able to learn to use their knowledge (1) that 2 tens is twenty, 3 tens is thirty, etc. and (2) that numerals are recorded by the number of tens and ones as a chain of reasoning which would make reading and writing numerals more meaningful. A child thinking in this way would almost certainly be more capable of transfer than a child who reads and writes numerals by using a left-right sound-sequence approach. It remains to determine the specific effects of teaching these counting skills and thinking strategies.

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Behr, Merlyn J. and Eastman, Phillip M. DEVELOPMENT AND VALIDATION OF TWO COGNITIVE PREFERENCE SCALES. Journal of Experimental Education 46: 28-34; Spring 1978.

Abstract and comments prepared for I.M.E. by MICHAEL BOWLING, Stephens College.

1. Purpose

The stated purpose was "the development of two scales to measure the cognitive preference of learners and a comparison of three populations based on these scale scores".

2. Rationale

In a 1967 study, Travers et al. investigated the cognitive preference of 115 seventh-grade students by presenting the subjects mathematical concepts in three modes -- graphic, verbal, and symbolic. The subjects were asked to indicate a preference for one of the three presentations, the choice representing the mode in which they would prefer having their teachers present it to them.

In the present study, the authors investigated the potential of cognitive preference and scale measurement for two reasons:

(1) "It was considered highly probable that the scales would discriminate between subjects and thus certain groups of people would exhibit similar cognitive preference scores; moreover, it was hypothesized that these scores would serve as good predictors for the mode of instruction from which groups of subjects would learn best."

(2) "It was considered probable that the cognitive preference scores of prospective or inservice teachers might be changed through instruction."

3. Research Design and Procedure

Working from the Travers instrument, the authors constructed two separate cognitive preference scales -- one (FS) to measure a figural-symbolic preference, the other (ID) to measure an inductive-deductive preference. Each scale consisted of items which presented seventh- or eighth-grade material from arithmetic, algebra, number theory, and geometry. Each item on the FS scale presented a concept in a figural mode (picture or diagram) and a symbolic mode (formula). Each item on the ID scale presented a concept in an inductive mode (two examples, then definition) and a deductive mode (definition, then two examples). The FS (ID) scale was scored by assigning a value of one for each figural (deductive) response, zero otherwise.

A pilot administration of the scales ($N = 92$) was conducted to test for effects due to the order in which the scales were given. It was concluded that the order "would not significantly affect the distribution of scores" on either scale.

The scales were then administered to two intact classes and a group of elementary school teachers ($N = 40$). The classes were a freshman/sophomore mathematics content course for prospective elementary teachers ($N = 92$) and an upperclass mathematics methods course for the same majors ($N = 38$).

Internal-consistency reliabilities (KR-20) were computed for each scale by group (except for the group of teachers). Mean, standard deviation, range of scores, kurtosis, and skewness were reported for each scale by group, and a 3x1 analysis of variance was conducted to determine whether the three groups differed in their mean scores on either scale.

4. Findings

Reliability coefficients were between .85 and .91 for both scales with the intact classes. Significant differences ($p < .01$) in skewness were found for both the content class and the teachers on the ID scale. Nearly the full range of scores appeared for both the FS (1-37, 39 items) and the ID (3-32, 32 items) scales.

For both scales, the F-value of the analysis of variance was significant ($p < .01$). Post-hoc analyses of the mean scores (Neuman-Keuls test) determined:

(1) The methods class and the teachers were significantly ($p < .01$) more figural in their preferences than the content class.

(2) The content class and the teachers were significantly ($p \leq .01$) more deductive than the methods class.

5. Interpretations

The authors concluded that both scales will discriminate between subjects and that "Some support exists to substantiate the conjecture that groups of people with different experiences or training exhibit a different cognitive preference."

It appeared that a group's cognitive preference could be attributed to the type of instruction and experiences it had recently undergone. For example, the higher figural scores for the methods class and the teachers might be a product of the ways in which mathematics was presented in the methods course and was taught by the teachers at the elementary school level. By the same token, the content class was probably exposed to a more symbolic presentation of concepts.

Cited as a limitation to conclusions from the study is the "first attempt" accuracy of the scales as cognitive preference measuring devices; in particular, it was felt that not enough attention was given to insuring that comparable levels of sophistication existed for both modes of presenting each concept.

The question of whether cognitive preferences are highly correlated with mathematical achievement under instruction in the preferred mode was seen as the next step in determining the potential of the scales.

## Abstractor's Comments

The authors' objectives for the study were commendable. If a student prefers presentations which are more figural in style than symbolic, or more inductive than deductive, then it is reasonable to expect the student to learn more when material is presented in that mode.

Unfortunately, the cited limitation in instrumentation is even more debilitating than acknowledged. The scales were adapted from an existing instrument, but there is no report of tests for content, construct, or even face validity. The scales exhibited differences between groups, but it is doubtful that it is known what these differences mean. The focus of the investigation should have been on instrumentation (as advertised in the title) and construct definition, not hypothesis testing.

There are several basic questions not addressed by the paper:

(1) Is "cognitive preference" learned? Is the symbolic mode simply at a higher level of abstraction than the figural? Bruner's writings might suggest that a person moves from one mode preference to another as he becomes more familiar with the concept.

(2) When was the study conducted? No reference cited is more recent than 1970.

(3) Would not chi-square testing be more appropriate for the scale scores than ANOVA? At any rate, a more conservative post-hoc test than Newman-Keuls should have been used (e.g., Scheffe).

(4) Were there differences in preferred mode by subject matter?

(5) Would not an item analysis following a trial run with the scales produce suggested revisions which might have alleviated the authors' concerns about homogeneity of item sophistication?

Brush, Lorelei R.; Brett, Leslie J.; and Sprotzer, Eve R. CHILDREN'S DIFFICULTIES ON QUANTITATIVE TASKS: ARE THEY SIMPLY A MISUNDERSTANDING OF RELATIONAL TERMS? Journal for Research in Mathematics Education 9: 149-151; March 1978.

Abstract and comments prepared for I.M.E. by BARBARA PENCE, Stanford University.

1. Purpose

This study investigated the claim that four- to six-year-old children who make errors on simple quantitative tasks are merely misunderstanding the experimenter's language.

2. Rationale

According to the Piagetian model, children's difficulties with number tasks are not caused by simple linguistics misunderstanding, but are rooted in conceptual difficulties. Earlier research conducted by the author (Brush, 1978) produced error patterns which neither confirmed nor denied the effect of language comprehension. Further investigation of the role of language in errors made on simple quantitative tasks was called for.

3. Research Design and Procedures

A simple two-treatment comparison was used. Sixty-four children (32 males and 32 females) from a predominantly middle-class community, with 32 children aged 4.0-4.11 and 32 aged 5.0-5.11, were randomly assigned to each of the two treatment groups. Each group received two training tasks and eight experimental tasks. The training tasks helped the students examine two jars of marbles. In the no "more" group, the students were asked, "Which jar of marbles will fill the board?" The "more" treatment group was given the identical task but asked, "Which jar has more marbles in it; which jar of marbles will fill the board?"

The eight experimental tasks (simple addition, addition inverse, simple subtraction, subtraction inverse, complex addition, complex subtraction, addition and inequality, and subtraction and inequality) were given to all subjects individually. No board was present during the experimental tasks for either group and in both cases the subjects were asked to compare the resulting number of marbles in each of two jars.

The discussion for the no "more" group centered on which the jars of marbles would fill the board, while the "more" group discussed which jar had more marbles in it.

Performance of the groups was measured by the mean number of correct responses within and across the tasks. Results were presented in a table which gave the means and corresponding percentages for each experimental task. No standard deviations were reported and no data were given. Analyses included simple t-test comparisons for each task and for the complete treatment means. No multivariate analyses were reported.

4. Findings

There were no significant differences between the performance of the "more" and no "more" treatment groups.

5. Interpretations

The authors' interpretation was that these results showed that "children's difficulties with simple arithmetic tasks were not purely linguistic, at least they did not disappear when relational terms were removed."

## Abstractor's Comments

I question the authors' conclusion both in terms of design and statistics. The design of the study involved only one relational term, "more", and the training process asked the student to make a transformation from the concrete equivalence of 24 marbles and 24 spaces on a board to the relational term "more". That is, when the number of marbles in the jar was equivalent to the board spaces, it is said that there are "more" marbles in that jar than in the comparison jar. The generalizability of this study only marginally includes the use of the term "more" and certainly does not extend to relational terms.

Even though the statistics presented failed to give important information such as standard deviations and also failed to compare the results as correlated multivariate data, the table of means contained a very interesting pattern. For the tasks of simple addition, simple subtraction, complex addition, and complex subtraction, the performance of the "more" group exceeded 90% correct, and was higher than the performance of the no "more" group in all but one case. On the other four tasks (addition inverse, subtraction inverse, addition and inequality, and subtraction and equality), the percentage correct for the "more" group varied from 50% to 65.6%; for the no "more" group, it varied from 65.6% to 71.9%. For each of these tasks, the performance of the no "more" group was higher than that of the "more" group. Combining the results across the two sets of tasks it would be possible to hypothesize that for the simple tasks, the existence of the word "more" facilitated performance, while for the difficult (or less common) tasks, the existence of the word "more" (or at least the required transformation) interfered with the performance. Since no standard deviations were reported, it could be that the differences between means is insignificant and should be ignored. The replicated effect for like tasks is, however, interesting.

The differential effect for the 4.0-4.11 and 5.0-5.11 age groups was not presented. I miss this separation, since schooling often begins with the 5.0-5.11 age group and may be a far more powerful intervention than the two-task transformation training provided in this study.

Eastman, Phillip M. and Salhab, Mohammed. THE INTERACTION OF SPATIAL VISUALIZATION AND GENERAL REASONING ABILITIES WITH INSTRUCTIONAL TREATMENT ON ABSOLUTE VALUE EQUATIONS. Journal for Research in Mathematics Education 9: 152-154; March 1978.

Abstract and comments prepared for I.M.E. by BILLIE EARL SPARKS, University of Wisconsin-Eau Claire.

1. Purpose

This was an aptitude treatment interaction study using absolute value equations as content. Specifically, using multiple linear regression will an interaction be found between treatment (algebraic versus geometric instruction) and two aptitude variables (spatial visualization and general reasoning)?

2. Rationale

The aptitude treatment interaction study has been used in a series of studies (Carry, 1968; Webb, 1971; Eastman, 1972) to assess the presence of an interaction between graphical and analytical instructional treatments and spatial visualization and general reasoning aptitudes. Carry and Webb used quadratic inequalities for content and found no significant interaction. However, using the same content Eastman found the hypothesized significant interaction. This study was conducted to see if the interaction found by Eastman would also be found using different content, specifically absolute value equations. This was undertaken to provide insight into how instruction may be best individualized to mesh with learner characteristics.

3. Research Design and Procedures

Fifty-nine elementary education majors enrolled in two sections of a methods course at the University of Texas were the subjects utilized for the study. The subjects were randomly assigned to two treatment groups.

The study was conducted over a four-day period. On day one, Abstract Reasoning Form A from the Differential Aptitude Test Battery was administered as a measure of spatial visualization aptitude, and

Necessary Arithmetic Operations from the Kit of Reference Tests for Cognitive Abilities was administered as the measure of general reasoning. On days two and three, programmed instruction sequences were studied by all subjects. One treatment group studied materials using the algebraic definition of absolute value and were instructed to solve all problems by an algebraic process using no visualization. The other treatment group studied materials defining absolute value as distance on the number line and were instructed to solve all problems by drawing a graph to help visualize the solution. On day four, an achievement test measuring learning and transfer was administered.

4. Findings

There was no significant difference between achievement test means for the two treatment groups.

The main hypothesis concerning aptitude treatment interaction was tested via multiple linear regression analysis. The interaction was found to be statistically significant ($p < 0.04$).

5. Interpretations

The authors state that this study shows that Eastman's finding on aptitude treatment interaction is generalizable to other content. They conclude that researchers need to continue varying the content with similar studies in order to provide more information on optimization of the learning situation for mathematics students.

Abstractor's Comments

Since this is a brief report, the soundness of the instructional sequence and procedure is hard to evaluate. However, the need for such studies can hardly be questioned. At the heart of the phrase "individualization of instruction" is the understanding that different students learn differently by different methods. Which students and which methods are what aptitude treatment interaction research should tell us.

The long series of studies of which this is the fourth seems to indicate that as research procedures are made more precise the expected interaction will be found. It would be hoped that more studies using different content and different types of subjects would be conducted using a similar research format.

Of question in the present study is the particular instructional format utilized, that is, programmed instruction. Since no achievement levels are given, it is difficult to assess whether this was an effective procedure with either type of student or instruction. However, the mode of instruction is also important to individualization and may be interactive with treatment and aptitude.

Also, since quality instruction usually depends on alternative instructional procedures to explain thoroughly, maybe an algebraic and geometric approach for all students would have been best. A third treatment group with the methods combined would have been an interesting addition.

Engelhardt, J. M. ANALYSIS OF CHILDREN'S COMPUTATIONAL ERRORS: A QUALITATIVE APPROACH. British Journal of Educational Psychology 47: 149-154; June 1977.

Abstract and comments prepared for I.M.E. by DONALD J. DESSART, The University of Tennessee, Knoxville.

1. Purpose

This study was designed to replicate and extend an earlier study by Roberts (1968)on failure strategies.

2. Rationale

Engelhardt observed that numerous studies had been conducted related to arithmetic achievement, but ". . . little attention has been focused on the qualitative aspects of children's errors, i.e., the types of errors they exhibit." The earlier study by Roberts was identified as an investigation in which an attempt was made to clarify errors according to the students' methods of attack (called failure strategies). Roberts identified four classes of errors: wrong operation, obvious computational error, defective algorithm, and random responses. Engelhardt was concerned that: (a) the class of random responses appears to be a "catch-all" for errors which do not fit into other classes of errors; (b) the class of defective error type has a sufficiently large number of subdivisions that merit separate consideration as error types; and (c) no remedial measures are inherently suggested by the defective algorithm or random response types of errors. Based upon these observations, Engelhardt felt that Roberts' study merited replication and extension.

3. Research Design and Procedures

The sample for the study consisted of a random selection of 198 students from the third and sixth grades of the Greater Phoenix area. Of the 198 pupils, 71 were selected from a rural district and 127 from an urban area. Pupils from both areas were equally represented by grade level and sex; and students from the rural areas were equally represented from four ethnic groups: Anglo, Mexican-American, Indian, and Black.

During a two-week period, all pupils were tested using 84 computation items from the Stanford Diagnostic Arithmetic Test. During the administration of the test any unusual behaviors, such as finger counting or saying "plus" in subtraction, were noted. No time limits were imposed, and students were encouraged to complete only as many items as they felt competent to complete. It was hoped that this would discourage random guessing on the part of students.

After the tests had been administered, the incorrect items were identified and analyzed to determine classes of errors. Finally, the error types within classes were studied to determine any generalizations.

4. **Findings**

The analysis led to the identification of eight types of errors. These are:

(a) Basic Fact Error: a computation involving an error in recalling a basic number fact.

(b) Defective Algorithm: the execution of a systematic (but erroneous) procedure.

(c) Grouping Error: error caused by a lack of attention to the positional nature of our number system.

(d) Inappropriate Inversion: a reversal of some critical part of the compuational procedure.

(e) Incorrect Operation: an operation other than the appropriate one.

(f) Incomplete Algorithm: a correct algorithm is begun, but is aborted or some critical steps are omitted.

(f) Identity Errors: "0" or "1" is used in a way that suggests confusion concerning identity properties.

(g) Zero Errors: difficulty with the concept of zero.

The students in the sample attempted 13,607 items and committed errors in 2,279 items. Since more than one error type was committed in certain items, the total number of errors (by type) was 2,687 (as summed by the reviewer from Table 2, page 153). The percentage distribution by error types (see Abstracter's Comments) is reported as follows: Basic Fact Error, 38%; Grouping Error, 22%; Inappropriate Inversion Error, 21%; Defective Algorithm Error, 18%; Incomplete Algorithm Error, 7%; Zero Error, 6%; Incorrect Operation Error, 4%; and Identity Error, 1%.

5. Interpretations

As can be seen from above, four error types (Basic Fact, Grouping, Inappropriate Inversion, and Defective Algorithm) accounted for most of the errors. The author concluded that the error type which appeared to distinguish highly competent from less competent performance was the defective algorithm type error, since virtually none of the top quartile performing students committed this type of error.

## Abstracter's Comments

Early in the report, Engelhardt observed that ". . . little attention has been focused on the qualitative aspects of children's errors . . .", which provided him motivation for this study. While there is a need for studies of computational errors and such studies have considerable merit, it is not entirely true that little work has been done. A review of NCTM's Classroom Ideas from Research on Computational Skills, 1976, pages 21-25, reveals that this subject has been the focus of no less than 15 to 20 studies in the past 25 to 30 years.

In Engelhardt's Table 2, "Distribution of Errors by Type" (p. 153), the reviewer calculated the sum of the "total" column to be 2,687 errors for a total of 117 percent! In recalculating the percentages using 2,687 as a base rather than 2,279 (as used in the study), the reviewer found the distribution of errors to be: Basic Fact, 32%; Grouping, 19%; Inappropriate Inversion, 17%; Defective Algorithm, 16%; Incomplete Algorithm, 6%; Zero, 5%; Incorrect Operation, 4%; and Identity, 1%. It is paradoxical that one finds computational errors in a study on computational errors. It seems to imply that the classification of error types is far from complete!

Engelhardt's study represents a serious attempt to define more carefully types of computational errors. The means of remediation particularly related to such technological advancements as computers and calculators are sorely needed, particularly as the competency test movements gain momentum in many states.

## Reference

Roberts, G. H. The Failure Strategies of Third Grade Arithmetic Pupils. Arithmetic Teacher 15: 442-446; May 1968.

Ginther, Joan R. PRETRAINING CHICANO STUDENTS BEFORE ADMINISTRATION OF A MATHEMATICS PREDICTOR TEST. Journal for Research in Mathematics Education 9: 118-125; March 1978.

Abstract and comments prepared for I.M.E. by F. RICHARD KIDDER, Longwood College.

1. Purpose

This study examined the effects of intervention on two mathematics predictor tests, the Arithmetic Reasoning Test and the Missing Words Test. In particular, does pretraining on similar items increase the reliability and predictive power of these tests when used to predict the mathematical achievement of seventh-grade Chicano students?

2. Rationale

Generally, ability tests which are good predictors of mathematical achievement for Anglo students are not satisfactory predictors for Chicano students. Bernal (1971) found that Chicano students benefited significantly on mental ability tests from an intervention that permitted them to learn the test marking strategies, whereas Anglo students did not gain from intervention. Since Bernal (1971) did not report the reliability or predictive power of the test following the intervention, Ginther examined these indicators as they pertained to the Arithmetic Reasoning Test and the Missing Words Test.

3. Research Design and Procedures

Subjects for the experiment were selected from seventh-grade students in a junior high school with a large Chicano population (44 percent of the participants were Chicano). A subject was classified as Chicano if he or she had a Spanish surname. Those students with English as a second language (ESL) were excluded from the study. A total of 136 students participated in the experiment.

Each subject was given five pretests: (1) Missing Words, (2) Arithmetic Reasoning, (3) Computation, (4) Comprehension, and (5) Factors and Primes. Each was also given a posttest, Factors and

Primes. Each participating seventh-grade class was randomly divided into two groups with the following pretraining-pretesting schedule:

Day 1:

| Group A | Group B |
| --- | --- |
| Pretrain on Arithmetic Reasoning Pretest (approximately 30 min.) | Administer Computation Pretest (13 min.) and Comprehension Pretest (17 min.) |

Administer Arithmetic Reasoning Pretest to entire class (5 min.).

Day 2:

| Group A | Group B |
| --- | --- |
| Administer Computation Pretest (13 min.) and Comprehension Pretest (17 min.) | Pretrain on Missing Words Pretest (approximately 30 min.) |

Administer Missing Words Pretest to entire class (5 min.).

Day 3: Administer Factors and Primes Pretest to entire class (approximately 10 min.).

The pretraining activities centered on test-taking strategies, not "coaching" for the tests.

After pretesting, subjects studied factors and primes at their own pace in a programmed text. Upon completion of this unit of study, the achievement posttest was administered. Three months later, at the beginning of the eighth grade, each subject was given a retest.

## 4. Findings

Item analysis and stepwise regression were performed separately for each group. On the Arithmetic Reasoning Pretest, Chicanos with pretraining had a reliability index (Cronbach's Alpha) of .57, compared to .26 for those Chicanos with no pretraining. For non-Chicanos, the indices were .59 and .58 respectively for those receiving and not receiving pretraining. The correlation indices of the Arithmetic Reasoning Test to the Factors and Primes Test were .67, .40, .53, and .49 for Chicanos with pretraining, Chicanos with no pretraining, non-Chicanos with pretraining, non-Chicanos with no pretraining respectively.

For both Chicano and non-Chicano groups, pretraining on the Missing Words Test did not increase the reliability; however, pretraining did produce an increase in predictive power, significant at the .15 level for Chicano students and .14 level for the non-Chicano students.

The reliability indices on the Arithmetic Reasoning Test in the retention study increased from .57 to .72 for Chicanos receiving pretraining, decreased from .26 to .08 for Chicanos not receiving pretraining, and remained stable for non-Chicano students.

5. Interpretations

Pretraining improved the reliability of the Arithmetic Reasoning Test for Chicano students, but did not for non-Chicano students. For Chicano students the predictive power was improved, significant at the .08 level.

For both ethnic groups pretraining on the Missing Words Test did not increase its reliability--the reliability for this test being high for all four groups. Pretraining on this test appears to have improved its predictive power for non-Chicano students but not for Chicanos.

The retention test showed that the effects of the pretraining were retained and in general, the results tend to confirm Bernal's (1971) findings that Chicano students benefit from intervention that permits them to learn test-marking strategies.

## Abstractor's Comments

Ginther suggests that the results of her study are important to anyone working with Chicano students. Intuitively, I would agree, but do the findings justify this statement?

In designing an experiment, it is basic that the statistical analysis be planned in detail before a single datum is collected. Would an experimenter accept, in advance, significance levels of .08, .14, or .15? It is doubtful. Hence, Ginther's statements on significance are suspect. Does the correlation .67 as compared to .40 really indicate that pretraining on the Arithmetic Reasoning Test improved its predictive power, that is, is the .08 level really significant? Is the predictive power of the Missing Words Test increased by pretraining when it was "significant" at the .15 level for Chicano students and at the .14 level for non-Chicano students?

Why were Chicanos with English as a second language removed from the study? Would we not like to make predictions as to their probable mathematics achievement also?

The abstractor agrees with the experimenter that the study needs to be replicated. It needs to be replicated in part because of its significance to the educational community and in part because of the questions raised herein.

Good, Thomas L. and Beckerman, Terrill M. TIME ON TASK: A NATURALISTIC STUDY IN SIXTH-GRADE CLASSROOMS. Elementary School Journal 78: 193-201; January 1978.

Abstract and comments prepared for I.M.E. by KENNETH E. VOS, College of St. Catherine.

1. Purpose

The primary purpose of the study was to determine if learner involvement was different for high, middle, and low achievers. A secondary purpose was to find out whether learners were more involved in some academic subjects than in others and whether specific types of classroom activities were associated with higher or with lower levels of learner involvement.

2. Rationale

It has been established that involvement in learning tasks is a necessary condition for school achievement. Mastery of material by the learner occurs only if the learner is involved in some way such as reading, reacting, or responding. Therefore learner involvement should be related to both achievement and the type of classroom activity.

3. Research Design and Procedure

The investigation involved six classes of sixth graders from two different schools. The classrooms were organized primarily as self-contained rooms. No class size or total number of learners was given. Information about the six teachers was not included in the study.

Data were gathered by six different coders using an observation technique. A total of 14 hours of coding information was collected in each classroom. The coding information was collected in four areas:

(1) Instruction setting: whole class with or without teacher; small group with or without teacher
(2) Type of activity, e.g., waiting for teacher, writing, drawing, talking
(3) Academic subject

(4) Level of task involvement

(a) Definitely involved--learner engaged in the assigned task

(b) Definitely not--behavioral evidence to indicate that the learner is not involved

(c) Can't tell--no behavioral evidence or conflicting evidence

(d) Misbehavior--inattention that is social in nature and distracting to others

The coders rated each learner in succession during the observation period.

Assignment of learners to a high, middle, or low achievement group was done by the classroom teacher. No achievement measure was used to assist with this assignment procedure.

Analysis of the data was descriptive. The most common measure was the percentage of learners within each level of task involvement.

4. Findings

High achievers were more involved on a task than low achievers (definitely involved: 75 percent (high) vs. 67 percent (low)). Females across all achievement groups were observed to be more involved than males (definitely involved: 74 percent (female) vs. 70 percent (male)).

During mathematics and spelling, a high percentage of the learners were definitely involved (mathematics, 76 percent; spelling, 79 percent). During reading, 70 percent of the learners were coded as definitely involved.

Learner involvement was much greater on a task assigned by the teacher (definitely involved: 74 percent) in comparison with a task chosen by the learner (definitely involved: 53 percent).

The findings show that learner involvement declines when the teacher interacts with the whole class and learner involvement increases in teacher directed small-group activities. The most frequent activity for a learner was writing (22 percent), with listening the next most frequent activity (16 percent). During the observation period, over 50 percent of the learner's time was spent working privately.

5. Interpretations

It is evident that teachers are using a variety of teaching settings within their classrooms. The stereotypic view of the teacher talking to the whole class was not supported in this study.

According to the findings, mathematics and spelling had the highest levels of learner involvement (mathematics, 76 percent; spelling, 79 percent). The authors questioned if it was reasonable to expect much higher involvement than possibly 85 percent. It would be reasonable to expect high involvement only if activities that are intense are followed by activities which offer time to relax or reflect on achievements.

A set of future research questions was given at the conclusion of the report.

## Abstractor's Comments

The authors should be commended for attempting to write a concise report. It was an easy-to-read report written for popular consumption. Unfortunately this desire to be concise (or possibly vague) raises a myriad of questions:

(1) Why were the class sizes omitted?

(2) Why was the total number of learners never mentioned?

(3) What information was available about the six different teachers? Would not the teaching style of the teacher influence learner involvement?

(4) What was the procedure for school selection?

(5) What was the time period of observation? The report states 14 hours total per classroom but when did these 14 hours take place? In two days? In seven days? Over six months?

The questions above could have been answered in only one to two paragraphs in the report. Why were they missing?

A minor point did disturb me. The tables (a total of nine) were printed at least three pages later than the written description of the tables. This lag reflects the inefficient table designs evident in the report. It would have been possible to report every bit of data collected using at most three tables.

An interesting aspect of the report was the high level of involvement for mathematics. It would have been advantageous to have time-on-task (average minutes per day on each academic subject) also studied in conjunction with this investigation. There would seem to be a tie between time-on-task and level of involvement. This investigation did not address this issue.

Given the concern for male and female attraction to mathematics, it would have been enlightening to have a male and female breakdown for the level of involvement in mathematics. Over all academic subjects, 75 percent of the females were definitely involved, in comparison with 70 percent of the males. Also, 0.4 percent of the males were coded as misbehaving while 0 percent of the females were coded as misbehaving. I believe these figures may show the bias of the coders.

There is a basic question that must be asked concerning this report: does the mathematics education community need a research report to say "low achievers are less involved than high achievers"? My second-grade son has already concluded this obvious observation from his few years of experience in a classroom.

Graeber, Anna O.; Rim, Eui-Do; and Unks, Nancy J. A SURVEY OF CLASSROOM PRACTICES IN MATHEMATICS: REPORTS OF FIRST, THIRD, FIFTH AND SEVENTH GRADE TEACHERS IN DELAWARE, NEW JERSEY, AND PENNSYLVANIA. Philadelphia: Research for Better Schools, Inc., 1977.

Abstract and comments prepared for I.M.E. by HAROLD L. SCHOEN, University of Iowa.

1. <u>Purpose</u>

This study was a survey of mathematics classroom practices and teacher characteristics in grades 1, 3, 5, and 7 in Delaware, New Jersey, and Pennsylvania. Data were gathered via teacher questionnaires concerning time spent teaching mathematics, use of motivators, classroom structure, classroom management, professional opportunities for teachers, and teachers' uses and attitudes toward uses of the hand-held calculator.

2. <u>Rationale</u>

The authors cite the Euclid Conference Report and the [illegible]COME Report as supporting the need for more dependable data on what actually happens in the classroom. The teacher questionniare was based on the 1975 NCTM survey and influenced by several other questionnaires and a number of expert advisors.

3. <u>Research Design and Procedures</u>

An original target sample of 3000 teachers was selected using a stratified sampling procedure to proportionally represent rural, city, suburban, and metropolitan schools in the three states and in grades 1, 3, 5, and 7. In early January 1977, each school's packet of materials was mailed to the school principals, who chose target teachers at the specified grade levels. By the February 15 deadline, 1343 questionnaires (43%) were completed and received. A stratified sample of 25 of the respondents was interviewed to determine how teachers interpreted the questions. For the most part, questionnaire results are summarized in terms of the percentage of responses to alternatives within the constructs described in the Purpose section. Conclusions were based on these findings and on insights derived from the interviews.

4. Findings

It is not possible to adequately summarize 30 tables of response frequencies in the allotted space. Therefore, the author's most interesting and sometimes most unexpected conclusions based on these responses are reported. Of course, the choice of results for inclusion here must be blamed on the abstractor's biases.

Concerning time, most schools had 180-184-day school years and the average school day was 5.25 hours long, with most mathematics classes meeting daily for 36-45 minutes. The most often reported number of minutes of daily class time spent on selected activities were are follows: introducing new work (11-15), practicing new work (11-15 in grades 1 and 5; 16-20 in grade 3; and 6-10 in grade 7), reviewing homework (0-5 in grade 1; 6-10 in grades 3, 5, and 7), practicing review concepts and drill on basic facts (6-10 in grades 1, 3, and 5; 0-5 in grade 7), and disciplining and managing non-mathematics oriented activities (1-5). Homework was never assigned by 48.9% of the first-grade teachers, while homework assignments four times a week were common at the other grade levels. One basic textbook was used by most or all students in 81% of first-grade classes, decreasing to 63% of fifth-grade classes.

Concerning motivators, 58.5% of the first-grade teachers reported using manipulative materials daily. This use decreased as grade level increased, with 37.2% of seventh-grade teachers never using manipulatives. The response pattern for use of games and puzzles was similar to that of manipulatives, although 42% of seventh-grade teachers reported using games and puzzles at least once a month. Over 50% of all respondents reported using metric measuring equipment less than once a month. At all grade levels surveyed, about 90% of the teachers reported that in mathematics they rarely or never use television, computer-assisted instruction, calculators, or computer terminals.

Concerning structure of the program and placement of students, 50% to 60% of the teachers reported that state mathematics objectives either do not exist, to their knowledge, or that state objectives exist but they do not use them. In fact, state mathematics objectives exist in all three states. On the other hand, district mathematics objectives were used to plan lessons by approximately 55% of the teachers, while over 70% at all levels used basal mathematics textbook objectives to plan lessons. The most typical class sizes ranged from 21-25 in grade 1 to 26-30 in grade 7. In first grade, 74.5% of the classes used heterogeneous grouping, while by grade 7 this has dropped to 38.5%, and 53.8% are homogeneous with a single group. Individualized instruction was used predominately by 10% of the first-and third-grade teachers, 16% in the fifth grades, and 7% in grade 7.

Concerning classroom management, 71% of the teachers at all grade levels reported having no classroom assistance of any kind.

Concerning professional opportunities of teachers, in grades one through five about 48% reported not having, and 42% to 44% reported having, a mathematics coordinator. Among seventh-grade mathematics teachers 59% had mathematics coordinators and 40% did not. About 95% of teachers in grades one through five do not have a membership in a mathematics teachers association, while 34% of grade 7 teachers are members of such an organization.

Concerning hand-held calculators, 94% of the teachers in grade one, 90.6% in grade 3, 79.6% in grade 5, and 73.6% in grade 7 reported never using a calculator in class. Teachers at each grade level indicated that the calculator was appropriate for a higher grade level. In first-grade classes in which calculators were used, 84.6% of the users reported that the calculator was used to provide drill in basic facts. Approximately 80% of the calculator users at the other grade levels reported using calculators for checking work. Most commonly cited reasons for not using calculators were lack of availability, prohibitive cost, and uncertainty about their effect on learning basic facts.

5. Interpretations

A few trends or themes were noted as follows.

1. Although most teachers rely on and follow the sequence of one basic text, they often devise their own supplementary worksheets and materials.
2. Evaluation for placement and assessment of pupil progress seems to be dominated by teacher-made measures and teachers' informal perceptions.

3. While standardized tests are widely used above the first grade level, they do not appear to play a major role in grouping procedures.
4. There is little evidence of a movement toward metric measurement or the use of hand-held calculators in the classroom.
5. Television, computers, and even manipulative materials have made few inroads into the curriculum.
6. While teachers believe that basic facts and computational algorithms are very important, the reported amounts of time spent on drill and practice did not reflect the concern for this area.
7. Over half the elementary school teachers either do not have or do not know they have a district mathematics coordinator. With few exceptions these teachers do not belong to a mathematics teachers' organization and are not apt to see their journals.

## Abstractor's Comments

The results of this survey are interesting. They are generally consistent with the results of three national surveys which will be summarized soon by James Fey in the Arithmetic Teacher and the Mathematics Teacher. It appears that many curricular and instructional innovations were figments of the imagination of educational writers and, in fact, had little impact on school practice. Fey also reports a strongly conservative attitude among teachers.

Assuming these surveys are accurate, and the evidence is mounting to support that assumption, how should these findings be interpreted? One interpretation is to view the teachers as a conservative (perhaps even lazy and ignorant) group who are the major cause of children's low levels of mathematics learning. Another view is to accept these findings as a part of real life in the classrooms, recognizing that teachers as a group are dedicated to children and their learning, but are faced with the very difficult task of meeting a broad set of needs of 25 children for six hours a day.

If we who write journal articles and other gems of wisdom in education respect teachers as competent, sincere, and capable of meaningfully interpreting their own experience (which is vastly different from our own), then it seems to me we are left with the second viewpoint. For educational researchers in the areas of curriculum and instruction, this says that we go to the practitioners for our theory. We begin by studying the real-world school situation, not by referring to psychological theory or academic speculation (although these will surely have a secondary bearing on our efforts). From this point of view, if "modern mathematics," individualized instruction, or any other innovation failed, it did not fail because of teachers. It failed because it did not account for educational realities, and teachers, with their strengths and weaknesses, are part of those realities. Granted, I have no foolproof answers for how to effect "desirable" changes in curriculum and instruction, but it appears to me that results of surveys such as this one suggest that we had best start with the real world and go from there.

A NOTE OF CLARIFICATION in regard to:

Pascarella, Ernest T. Interactive Effects of Prior Mathematics Preparation and Level of Instructional Support in College Calculus. American Educational Research Journal 15: 275-285; Spring 1978.

Pascarella, Ernest T. Student Motivation as a Differential Predicator of Course Outcomes in Personalized System of Instruction and Conventional Instructional Methods. Journal of Educational Research 71: 21-26; September-October 1977.

Pascarella, Ernest T. Interaction of Motivation, Mathematics Preparation, and Instructional Method in a PSI and Conventionally Taught Calculus Course. AV Communication Review 25: 25-41; Spring 1977.

All were abstracted in IME in Volume 11, No. 2, Spring 1978, pages 43-45.

The author of the articles, Ernest T. Pascarella of the University of Illinois at Chicago Circle, sent the following note of clarification:

> In my recent articles abstracted in IME there is a factual error attributable more to my reporting of the findings than to the abstractor's reading of the findings. The studies are in fact based on three independent samples, not one. There is also a clear replication of the mathematics preparation x instructional support interaction in the AERJ paper.

Sawada, Daiyo and Jarman, R. F. INFORMATION MATCHING WITHIN AND BETWEEN AUDITORY AND VISUAL SENSE MODALITIES AND MATHEMATICS ACHIEVEMENT. Journal for Research in Mathematics Education 9: 126-136; March 1978.

Abstract and comments prepared for I.M.E. by PAUL C. BURNS, University of Tennessee, Knoxville.

1. Purpose

The general hypothesis to be tested is that there exists a predictive relationship between modality matching abilities and mathematics achievement. Four specific hypotheses are:

a. There exist significant correlations between mathematics achievement and modality matching abilities.
b. There is significant variation in these correlations across three IQ ranges (low, medium, and high).
c. The magnitude of the correlations involving mathematics and their variation over the IQ ranges will be as great as or greater than the correlations involving reading achievement.
d. The intercorrelations of the Modality Matching Abilities show significant variation across the three IQ groups.

2. Rationale

A review of recent literature reveals a paucity of mathematics education research that incorporates sensory modality matching ability as a central variable. (The Sensory Modality Matching paradigm is one in which a stimulus pattern is presented in one sense modality and the child's task is to identify an equivalent pattern in the same or in a different modality.) The authors believe many, if not most, learning experiences in school mathematics assume that the pupil is competent in higher-order mediational forms of matching. Research involving multiple embodiment using different modes of representation (often conducted in a mathematics laboratory) has been inconsistent and has resulted in unsupportive conclusions in terms of mathematics, but, in contrast, has resulted in support of the conclusion that auditory-visual matching ability significantly predicts reading ability.

3. Research Design and Procedures

The final sample consisted of 180 fourth-grade boys selected in a stratified random manner from 19 public schools in predominantly middle socioeconomic areas in Edmonton, Alberta. The accessible population was stratified into three IQ ranges (71-90, 91-110, and 111-130), based on the verbal IQ score of the Lorge-Thorndike Intelligence Tests, with 60 boys selected from each of the three IQ ranges, previously excluding any subjects with identifiable family, personal, or disability problems. The sex variable was held constant in order to avoid any spurious correlations due to disparate means for boys and girls on any of the variables.

Four modality matching tests were developed for the study: (1) auditory-auditory (AA) matching; (2) auditory-visual (AV) matching; (3) visual-auditory (VA) matching; and (4) visual-visual (VV) matching. All tests were of the multiple-choice format, consisted of 35 items each, the first 5 of which were used for practice. Below is an example of an auditory-visual match task:

Stimulus pattern (beeps)

o     o o o o     o o

Comparison pattern (dots)

•     • • • •     • •

The child was presented with a temporally ordered pattern of "beeps" and was to match this pattern with a spatially presented set of dots. A common stimulus item was used for AA, AV, and VA, but the visual-visual test required the inclusion of more complex patterns in order to avoid ceiling effects. KR-20 reliability coefficients for the four tests ranged from 0.60 to 0.84.

Four achievement measures were utilized. Three subtests were taken from the Stanford Achievement Test, Form W, 1965: Word Meaning, Paragraph Meaning, and Word Study Skills. The Mathematics Achievement Test was one produced by the Edmonton Public School System; the KR-20 was 0.87. This test is tailored to measure the behavioral objective cited in the Edmonton mathematics program.

A simple four-by-four Latin square design was used to balance the order of administration of the modality matching tests. The modality matching tests were administered in small groups of four to six subjects, while the achievement data were obtained from central office files.

4. Findings

The data supported the four hypotheses: there existed significant correlations between mathematics achievement and modality matching abilities: there was significant variation in these correlations across the three IQ ranges; the magnitude of the correlations in the modality matching abilities showed significant variation across the three IQ groups. For mathematics, there was a correlation of 0.56 with AA matching ability in the low IQ group and significant relationships between mathematics achievement and all the modality matching abilities (AA, AV, VA, VV) for the high IQ group. All five significant correlations involving mathematics were as great or greater than those obtained for reading. The changing relationship of AA performance to the other three modality matching abilities gave support to the fourth hypothesis.

5. Interpretations

While it is concluded that there is a relation between modality matching ability and mathematics achievement, it appears to depend on (a) the type of modality matching involved and (b) the IQ level of the pupil. With pupils of low intelligence, the auditory-auditory matching ability is a good predictor of their mathematics learning. In the high IQ group, mathematics achievement seems to be uniformly dependent on all four modality matching abilities, but this seems to not hold with pupils of medium intelligence.

## Abstractor's Comments

The researchers are to be commended for the clear and comprehensive description of the study and for thoughtful discussion and interpretation of the findings. Their comments on recent related studies (cited in the references) indicated acquaintance with previous work, permitting the present researchers to build upon it.

It appears that further study of the relevancy of sensory modality matching ability for mathematics (a counterpart to much work of this nature in the field of reading) is justified. Further research could attempt to study both sexes at various grade levels, particularly first- and second-grade levels. Other sensory modalities, particularly the kinesthetic, could be incorporated into the design, as well as a combination of modalities. The use of a standardized mathematics test as an achievement measure provides some readers more confidence in the results.

Once verified and refined as modality tests, another step would be to simplify the modality tests as much as possible so that they could be easily and rather quickly administered by the classroom teacher. Equally important, teachers, upon interpretation of test results, would need assistance in methods and materials for adjusting or individualizing instruction to differing sensory modality abilities.

Walton, Gene A.; Havens, Kathryn Ellen; Johnson, Helen Delores; and Paige, Donald. A FOLLOW-UP STUDY OF TWO METHODS OF TEACHING MATHEMATICS: TRADITIONAL VERSUS NEW MATH. School Science and Mathematics 77: 251-254; March 1977.

Abstract and comments prepared for I.M.E. by DOYAL NELSON, University of Alberta.

1. Purpose

The stated objectives were as follows:

(a) to study the effects of traditional versus modern mathematics on students

(b) to study the outcome of modern math (sic) and any impairments that might occur in later levels of mathematics

(c) to study differences in grades and standardized mathematical test scores in two different patterns of mathematics learning

2. Rationale

The mathematics grades assigned by teachers at the ninth-grade level were compared for two groups of students selected at the seventh grade. The control group had taken traditional mathematics in grade seven while the experimental group had taken a program in new mathematics in that grade. Apparently, though not stated specifically, both groups had similar mathematics instruction after grade seven. In any case, there were no differences noted in teacher-assigned mathematics grades at the end of grade nine.

In the study reported here, a composite of high school mathematics grades (Algebra I, Algebra II, and Geometry) assigned by teachers were obtained from school records and compared for the same two groups to test further the effects of the different instructional problems which occurred in grade seven. The records also contained Practice Scholastic Aptitude Test (PSAT) scores and these scores were also compared for the same two groups.

## 3. Research Design and Procedure

Ninety subjects were chosen randomly from among a 1965-66 seventh-grade population following a traditional program in mathematics. These comprised the control group. Ninety more subjects chosen from a 1966-67 seventh-grade population following a program in "new" mathematics were matched one-by-one with the control subjects and were called the experimental group. Matching was based on mathematics grades and Iowa Arithmetic Test scores. The teacher-assigned mathematics grades of some members of these two groups were compared in a previous study at the end of grade nine and there was no significant differences noted in the grade distributions.

High school mathematics grades consisting of Algebra I, II, and III and Geometry were taken from school records for the students remaining in these two groups. PSAT scores for them were also obtained from records. There were fifty-five of the original ninety subjects still in the control group and fifty-eight of the original ninety in the experimental group. How much matching still existed is not given. The composite mathematics grades and PSAT scores were compared by using chi-square and t respectively. Chi-square tests were used to compare the distributions of high and middle achievers as well as the total group. The t-tests were employed to compare high, middle, low, and total PSAT scores for the two groups.

## 4. Findings

Two tables included in the study summarize the findings and are reproduced here.

## DISTRIBUTION OF COMPOSITE GRADES

| TABLE | A | B | C | D | F* | STUDENTS |
|---|---|---|---|---|---|---|
| I High school mathematics grades of twenty-two high achieving Senior high school control and experimental students. | 16 | 11 | 15 | 12 | 0 | Control |
| | 24 | 25 | 13 | 4 | 0 | Experimental |
| II Senior high school mathematics grades of the seventeen middle-achieving senior high school control and experimental students. | 1 | 6 | 17 | 9 | 3 | Control |
| | 2 | 26 | 15 | 6 | 0 | Experimental |
| III Mathematics grades of the fifty-five senior high school control and experimental group students. | 19 | 26 | 48 | 30 | 4 | Control |
| | 28 | 57 | 43 | 21 | 0 | Experimental |

Note: $X^2$ for Table I = 10.089
Table II = 14.904
Table III = 17.622
$X^2$ at .05 level of confidence = 7.962

Planned comparisons (t-tests) of Practice Scholastic Aptitude Test (PSAT) scores for the high-, middle-, and low-achieving control versus the high-, middle-, and low-achieving experimental students and the fifty-five control versus the fifty-eight experimental senior high school subjects.

| Subjects | t-tests scores |
|---|---|
| High-achieving Control versus Experimental | 2.442* |
| Middle-achieving Control versus Experimental | 1.613 |
| Low-achieving Control versus Experimental | .657 |
| Control group versus Experimental | 2.021* |

*Significant at the .05 level of confidence.

A third table summarized the ninth-grade study and is reproduced here so it can be referred to later.

DISTRIBUTION OF GRADES

| TABLE | A | B | C | D | F* | STUDENTS |
|---|---|---|---|---|---|---|
| I Twenty-two high-achieving ninth-grade control and experimental students. | 4 | 5 | 9 | 4 | 0 | Control |
| | 5 | 10 | 5 | 2 | 0 | Experimental |
| II Seventeen middle-achieving ninth-grade control and experimental students. | 1 | 3 | 8 | 3 | 0 | Control |
| | 1 | 11 | 5 | 2 | 0 | Experimental |
| III Sixteen low-achieving ninth-grade control and experimental students. | 1 | 3 | 9 | 3 | 0 | Control |
| | 2 | 1 | 8 | 6 | 0 | Experimental |
| IV Fifty-five ninth-grade control and experimental group students. | 6 | 11 | 26 | 10 | 2 | Control |
| | 8 | 22 | 18 | 10 | 0 | Experimental |

*A = Excellent, B = Above Average, C = Average, D = Below Average, F = Fail

Note: $X^2$ for Table I = 3.587
Table II = 6.840
Table III = 2.404
Table IV = 7.309
$X^2$ at .05 level of confidence = 7.962

5. Interpretations

The general finding was that the experimental group obtained significantly higher mathematics grades in high school than did the control group. The same kind of finding also applied to the PSAT test scores.

In the discussion the authors claim the study indicates that the better students, if challenged and motivated to learn, possess the potential to excel and benefit from the modern approach to mathematics instruction. The average student who had had "modern" mathematics instruction in seventh grade apparently did not come up to the expectations of the investigators, while low achievers from the grade seven class who had instruction in "modern" mathematics showed no superiority at all. In any case, the authors claim that the study demonstrates an advantage of the new curriculum in mathematics over the conventional one. They also imply that participation in the new mathematics curriculum in seventh grade resulted in higher mathematics achievement and better ability scores several years later in senior high school.

## Abstractor's Comments

Before placing any confidence at all in the reported results of this study, readers should consider the following:

1. Why would the investigators go to all the trouble of getting matched samples when all the subsequent analyses were on few more than half the original sample and no attention given (or at least reported) to whether there remained any matching or not? What does this say about the randomness of the samples? Why weren't new samples chosen with some demonstrable randomness?
2. Why would the table for the distributions of mathematics grades in ninth grade suggest that there were "Seventeen middle-achieving ninth grade control and experimental subjects" when, in fact, there were 15 control subjects and 19 experimental subjects? The casual reader might miss discrepancies such as this and go on assuming that the information was on matched groups.
3. What high school mathematics grades were included in the high school composite? The total number of grades shown for the 58 experimental subjects was 149 while for the 55 control subjects the number was 127. In one place in the report we are told the high school mathematics grades included Algebra I and II and Geometry. On the same page we are told the composite (shouldn't it be aggregate?) grades were made up from Algebra I, II, III, and Geometry. One has to assume that the composite of these teacher-assigned high school mathematics grades were not for the same mathematics courses for every student. What sort of

unknown effects would this introduce into the composite (aggregate) distributions?

4. Why were not all points listed under <u>Purposes</u> attended to? For example, what attention was given at all to "impairments"? Is the word "math" used in that section meant to mean mathematics?
5. How does one explain the "no significant differences" in grade nine when followed by significant differences in high school? Is there assumed to be a delay effect of new mathematics instruction that doesn't surface until after three, four, or five years?
6. How could one accept from evidence in this report that "better students if challenged and motivated to learn, possess the potential to excel and benefit from the modern approach to mathematics instruction"? There is absolutely no evidence presented that students were challenged and motivated more in one mode at the grade seven level than in the other. The statement that "the improvement of the new curriculum over the conventional one warrants the utilization of this innovative technique" is not supported by any data supplied and as far as I can see has not even been addressed.
7. What was the history of these two groups of students from grade seven through grade twelve? What instructional differences, if any, were there after grade seven? In fact, one wonders what differences in instruction there really were in seventh grade.

There are many other serious questions which could be asked about this report. The number of unanswered questions leads one to conclude that it cannot be a faithful report of what happened during and in the investigation. If it is not a faithful report, why would it be accepted for publication?

Whyte, Lillian. LOGICO-MATHEMATICAL AND SPATIAL DEVELOPMENT IN CHILDREN UNDERACHIEVING IN ARITHMETIC. <u>Alberta Journal of Educational Research</u> 22: 280-296; December 1977.

Abstract and comments prepared for I.M.E. by MARTIN L. JOHNSON, University of Maryland.

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1. Purpose

Four questions were investigated:

(a) Will elementary school children classified as achievers, underachievers, and nonachievers in arithmetic be characterized by specific patterns of development on the WISC, tests of logico-mathematical concepts, and/or tests of spatial development?

(b) If specific patterns of development do characterize children at the three achievement levels, will the patterns also vary across the variable, chronological age?

(c) Are one or more measures of spatial development related to arithmetic achievement?

(d) Which of the four areas of the natural number system assessed are most seriously deficient at each of the three chronological age levels?

2. Rationale

The etiology of arithmetical disability has been the subject of much research. Two theoretical positions emanating from this research identify both cognitive and spatial-motor factors as being related to arithmetic performance. The ability to conserve has correlated significantly with arithmetic achievement in young children. In kindergarten and grade one, nonconservation in number concepts appears to be an etiological factor in arithmetic disability. There is insufficient evidence regarding the relationship of other logico-mathematical tasks, such as classification and arithmetic achievement among older children, although it is postulated that arithmetic difficulties are related to preoperational thought level on such tasks. A second position is that arithmetic disabilities are related to and possibly caused by spatial-motor disabilities. Many studies are reported in which performance on perceptual and representational space tasks correlate significantly with arithmetic performance with children younger than nine years. The exact relationship between spatial-motor ability and arithmetic ability is of yet undetermined.

## 3. Research Design and Procedures

The sample consisted of 87 children from three age levels: seven, nine, and eleven years. At each age level children were identified as arithmetic achievers, underachievers, and nonachievers based on their total arithmetic score on a diagnostic test. Achievers and underachievers were selected from a large elementary school serving a wide economic mix. Nonachievers at ages nine and eleven were selected from classes for learning disabled, while seven-year-old nonachievers were referred by school psychologists from two elementary schools.

The tests given were the WISC; three Piagetian logical thinking tests on classification, number conservation and seriation, conservation and measurement of length; visual perception using the Frostig Developmental Test of Visual Perception; motor development using the Oseretzky Test of Motor Development; and five Piagetian tasks of representational space.

The Tukey Gap Value Statistic was used to identify significant differences among means ($p < .01$) across the 35 variables measured. A multiple stepwise regression analysis was computed for the three age levels to determine which variables were contributing the greatest percentage of variance for the Total Arithmetic Score.

## 4. Findings

Verbal IQ was a significant factor at all age levels, although performance IQ was not. Most subjects were operational in number conservation, conservation of length, and measurement tasks. Only two groups were operating at the expected stage on the seriation task. Seriation, class inclusion, length conservation, and number conservation accounted for 71.69 percent of the variance at the seven-year level. "At the nine-year level, WISC Vocabulary and a Piagetian measurement task accounted for 61.16 and 15.19 percent of the variance, respectively. Figure Ground and Form Constancy from the Frostig were significantly related, but only at ages seven and nine. Motor ability was not significantly related. One of the five representational space tasks, the concept of opposition of left and right, was significantly related to arithmetic achievers but only at the eleven-year-old level, contributing 34.40 percent of the variance, while WISC verbal IQ contributed 31.26 percent." Seven-year-old underachievers had most difficulty with place value, while computational skills was most difficult for nine- and eleven-year-old underachievers.

5. Interpretation

The author concluded that "specific patterns of cognitive and spatial-motor development do characterize school children at different achievement levels and the patterns do vary with chronological age." Logico-mathematical concepts play a role in arithmetic performance at seven but decrease in importance as age increases. The lack of significance at age eleven of visual perception was viewed as indicating that children begin to move away from purely perceptual strategies at about nine years of age.

## Abstractor's Comments

The etiology of arithmetic disability is among the priority topics for mathematics education researchers. Studies are desperately needed to help researchers and practitioners with this problem. This study, unfortunately, gives no new insight. Few interpretations can be drawn from this study because of serious omission problems. A few such problems are listed below:

1. Sample selection procedures were not clear. This study would be quite difficult to replicate because too little is known about the sample.
2. No description was given of the diagnostic test. What were the items? Since achievement classification were made from performance on this test, some mention should have been made of test validity, specific directions about administration procedures, and a description of scoring criteria.

3. The method used to designate achievers, underachievers, and nonachievers is very questionable. For instance, if two children scored at the 75 percent level, did they answer the same items? If not, why group them together as achievers with the implication that they were comparable in arithmetic knowledge?

4. Group statistics often tend to hide important relationships. An analysis of the performance of each child across tasks would have allowed the researcher to identify specific patterns of behavior. This type of information is much more useful to researchers and practitioners attempting to plan programs and teach children with arithmetic disabilities.

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